

The 557th Weather Wing

Employing Multiple Drought Indices for Global Decision Support



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Overview



- **14th Weather Squadron (14 WS) – who are we?**
 - **Specialized support squadron of the 557th Weather Wing**
 - **Located in Asheville, NC**
- **Drought monitoring importance**
- **Current 14 WS drought monitoring capability**
- **Example cases of incorporating multiple drought indices**
- **End goals**



14th Weather Squadron



Mission: Collect, protect and exploit authoritative climate data to optimize military and intelligence community operations and planning



Vision: Innovative Airmen, delivering cutting-edge climate services capabilities to win the fight...today & tomorrow

CHOOSE THE WEATHER FOR BATTLE



Climate Services Continuum



Climate services span the past, present, and future climate system...

Core Climatology
Exploit historical data to characterize the environment

Monitoring
Monitor real-time data to assess the state of the climate

Analysis
Place current conditions in historical context

Prediction
Predict subseasonal-to-seasonal conditions

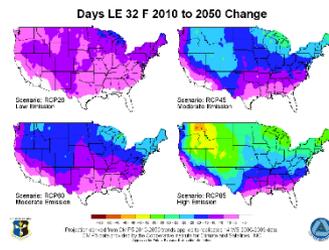
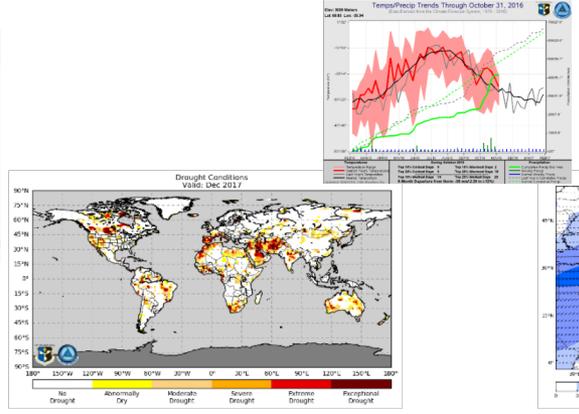
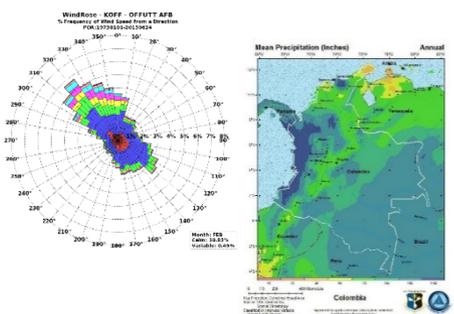
Projection
Assess the impacts of a changing climate



Enduring Mission
Mature Partnerships

Growth Areas
Maturing Partnerships

Limited Capabilities
Identifying Opportunities

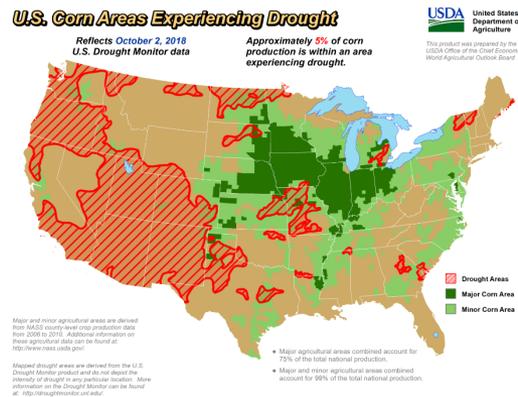
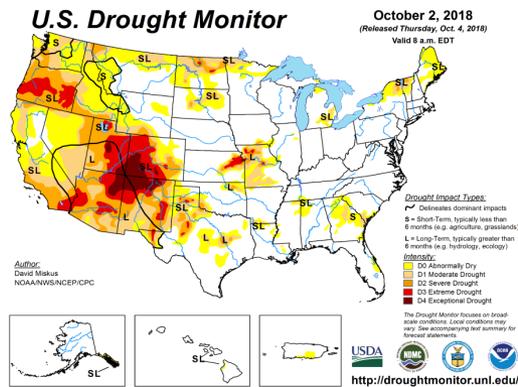




Drought Monitoring Importance



- 14 WS provides worldwide drought analysis with an emphasis on overseas locations



- Drought is a threat multiplier with impacts to human migration, conflict, economics, etc.
- Customers request water analysis products to help inform decisions regarding:
 - Agriculture
 - Water resources/security
 - Trafficability
 - Fire management



14 WS Drought Monitoring



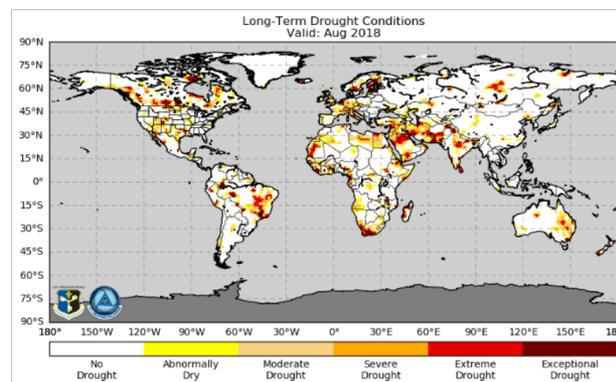
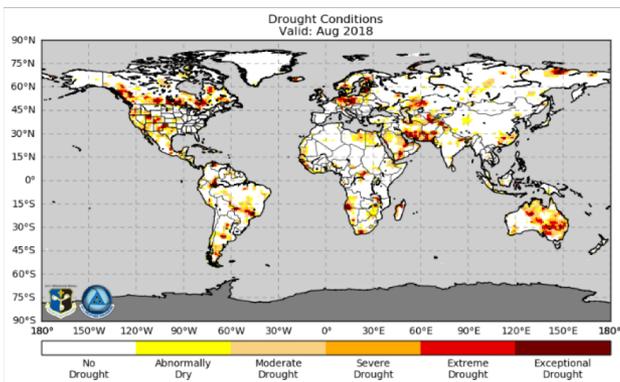
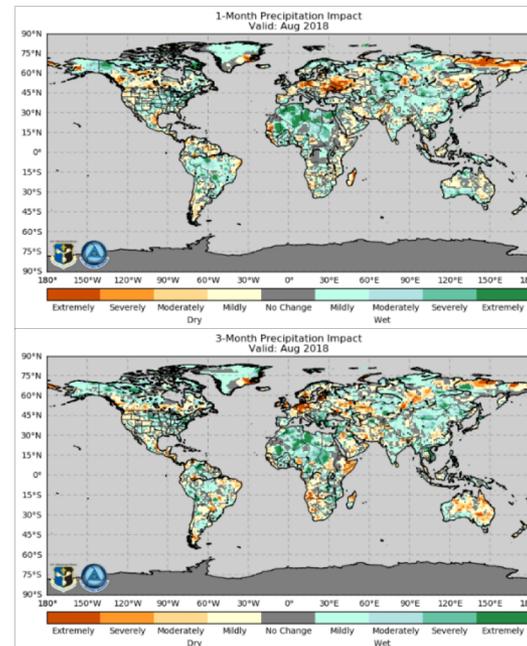
- **“Subjectivity in the definition of drought has made it very difficult to establish a unique and universal drought index” (Heim 2002)**
- **We compute the Standardized Precipitation Index (SPI; McKee et al. 1993)**
 - Normalized deficit of precipitation
 - Dataset: Global Precipitation Climatology Centre (GPCC)
 - Pros: lightweight, applicable across a range of time scales and precipitation regimes
 - Cons: no direct temperature or evapotranspiration influence and values based on preliminary data may change



14 WS Drought Services

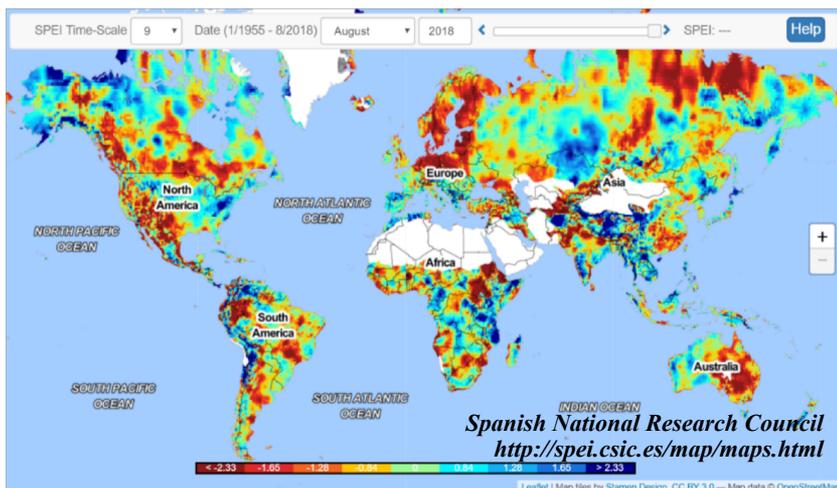


- Analyze at 1, 3, 9, 24 month indices
 - 1 and 3 months used for flash drought and drought emergence
 - 9-month used for long-term agricultural
 - 24-month used for entrenched drought impacts
- Produce a forecast outlook

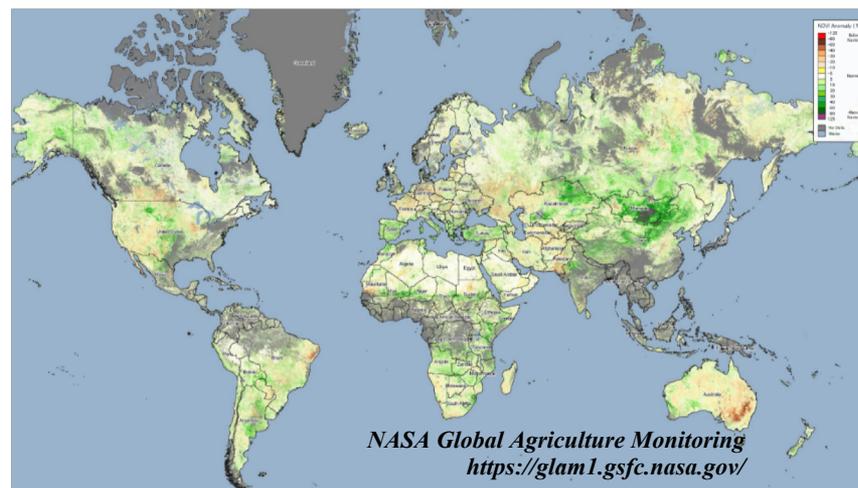




Additional Drought Tools



Standardized Precipitation Evapotranspiration Index



Normalized Difference Vegetation Index

■ We leverage ...

- SPEI used to enhance SPI to take into account evapotranspiration and temperature effects
- NDVI used to assess current and previous state of vegetation



14 WS Drought Monitoring



■ Standardized Precipitation Evaporation Index (SPEI; Vicente-Serrano et al. 2010)

- Calculation exactly like SPI but with an additional potential evapotranspiration calculation used
- Pros: uses temperature and evapotranspiration, lightweight, and applicable across a range of time scales and precipitation regimes
- Cons: not as well tested in as many locations as SPI

■ Normalized Difference Vegetation Index (NDVI) anomalies

- Satellite remote sensors quantify the amount of absorption or reflection by vegetation of photosynthetically active radiation
- Pros: can be used to assess the health of vegetation and can be used as a drought proxy
- Cons: only 20 years of data and data are unavailable in cloudy regions

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

NIR = Near IR channel ~0.8 μ m

Red = Red channel ~ 0.65 μ m



Drought Analysis Products



Afghanistan Forecast

Signals suggest that temperatures are forecast to be near average across most of the country. Precipitation is forecast to be near average throughout the entire country, but this will not help the ongoing drought situation affecting the majority of the country. Large 6-month precipitation deficits, low snow water content, and low soil moisture are contributing to the severe drought conditions across northern and southern Afghanistan. Due to minimal precipitation and warmer than normal temperatures, drought conditions are likely to persist and/or expand. The only probable locations for rainfall will be near the far eastern border where monsoonal influences may spill over from Pakistan and interact with the higher terrain.

Afghanistan and Pakistan

Analysis: Abnormally dry to exceptional drought conditions continued throughout northern and southern Afghanistan as well as northern and southern Pakistan. Near normal precipitation was observed throughout Afghanistan. Northeastern Pakistan experienced above normal precipitation due to monsoonal influences. Temperatures were 3 – 6 °F above normal throughout the region.

Prediction: Drought conditions are forecast to persist throughout the region. Below average precipitation is forecast throughout the majority of Pakistan and Afghanistan throughout September, with relief starting in mid to late October. Precipitation is forecast to be slightly below normal across Pakistan throughout September as the monsoon retreats. Temperatures are forecast to be above normal during the forecast period.



Case Studies

- Europe fires – situational awareness
- Southern Brazil drought – support request from USAID
- Central America flash drought – situational awareness





Summer 2018 News Headlines



Evacuations ordered in Sweden as fires rage as far north as Arctic Circle 

Wildfires rage across Europe as countries battle intense heat wave 



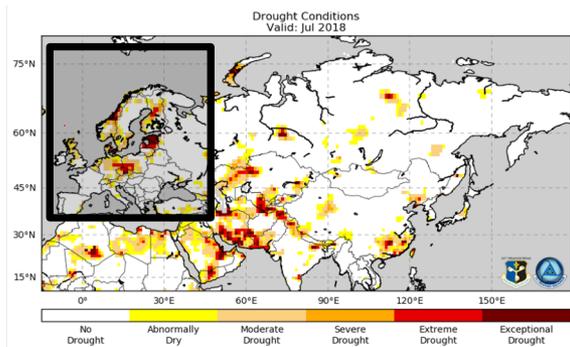
Scarcely Seen Scandinavian Fires

Capital Weather Gang

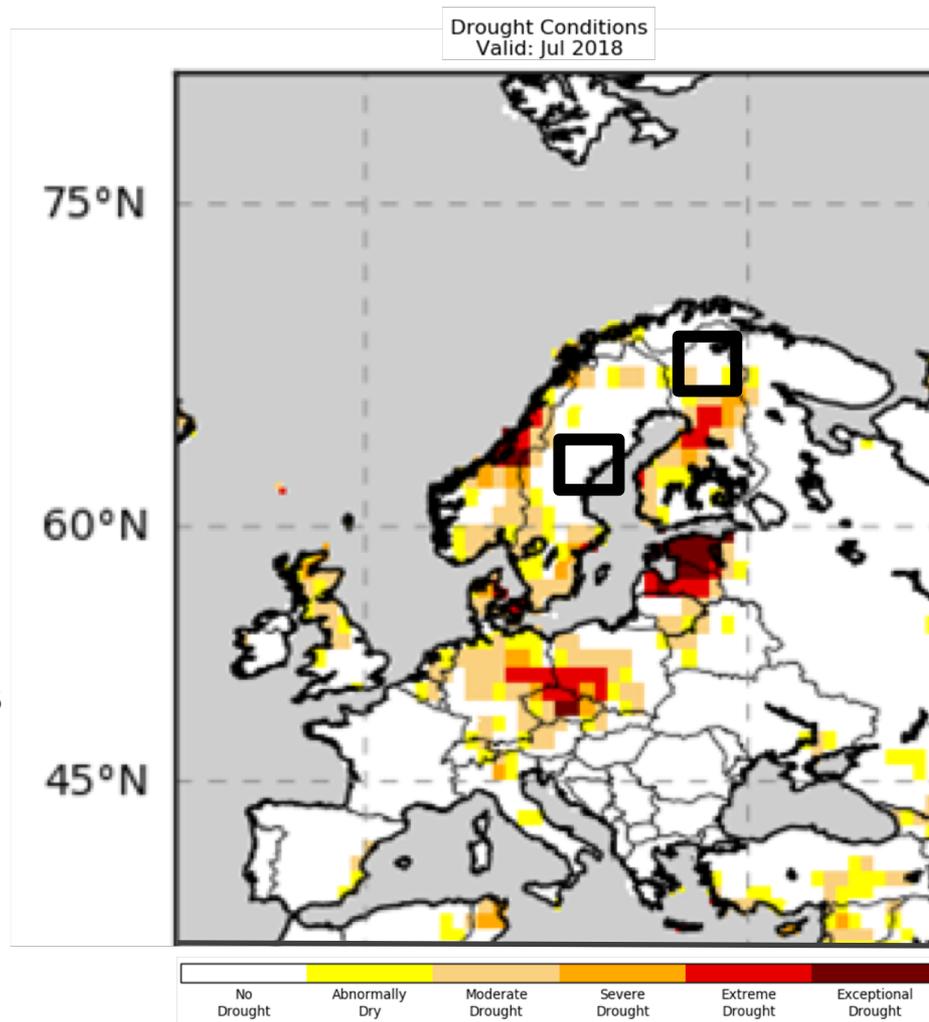
Temperatures near or pass all-time records in Europe as another heat wave blasts the continent 



Western Europe



- SPI₉ alone fails to show extent of drought conditions in the highlighted areas of Scandinavia.

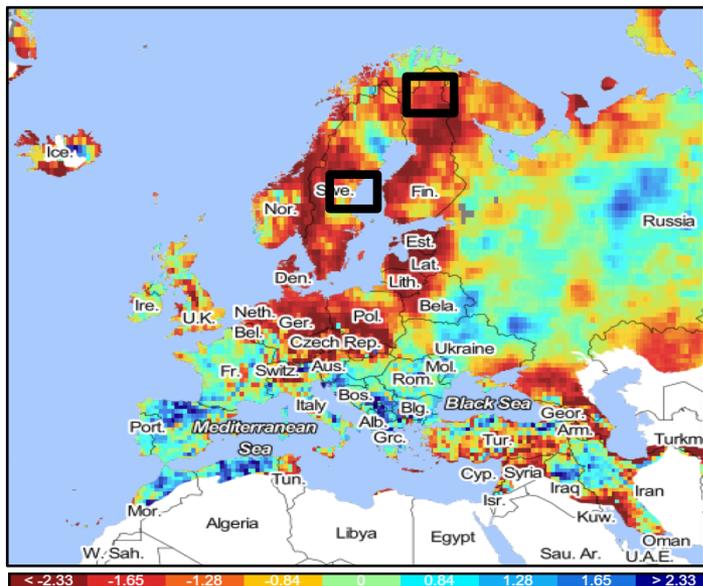




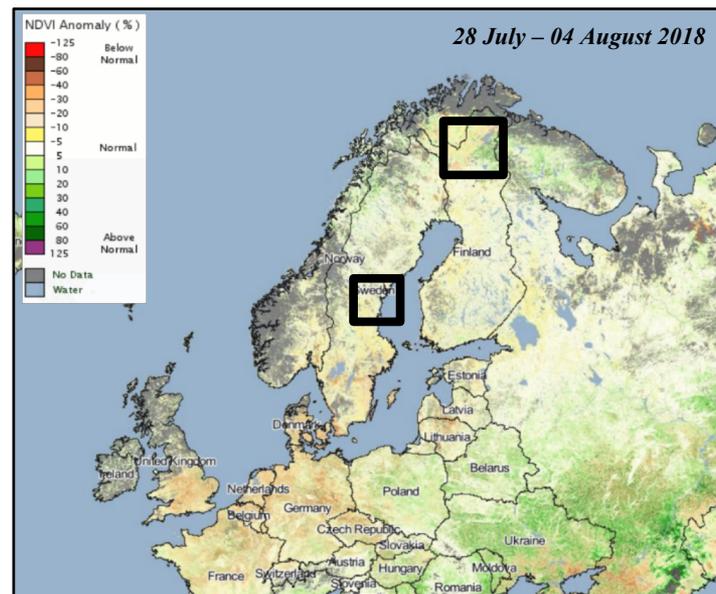
Western Europe



9-Month SPEI Valid: November 2017-July 2018



Source: Spanish National Research Council <http://spei.csic.es/map/maps.html>



Source: NASA Global Agriculture Monitoring <https://glam1.gsfc.nasa.gov/>

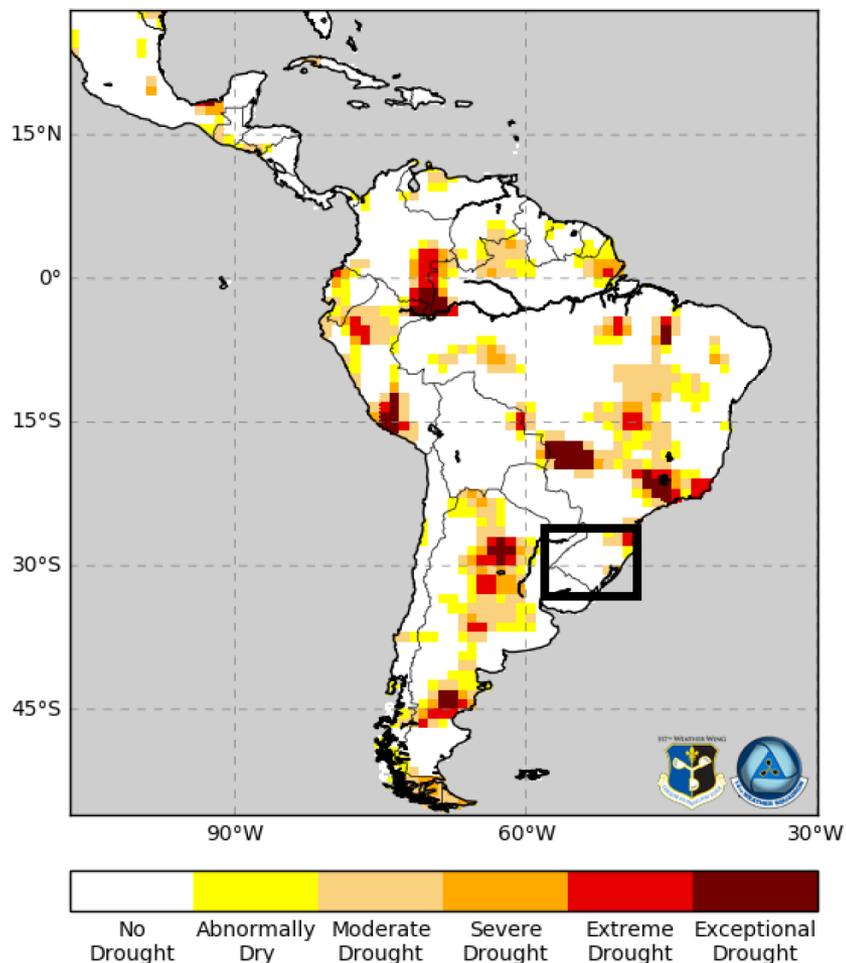
- **SPEI better highlights the drought-stricken Scandinavian countries.**
- **NDVI anomalies were below normal across much of western Europe, especially Sweden and Finland – indicative of elevated fire potential.**
- **Record high temperatures and multiple fires occurred across Scandinavia and Western/Southern Europe during the summer of 2018.**



Southern Brazil Drought



Drought Conditions
Valid: Mar 2018



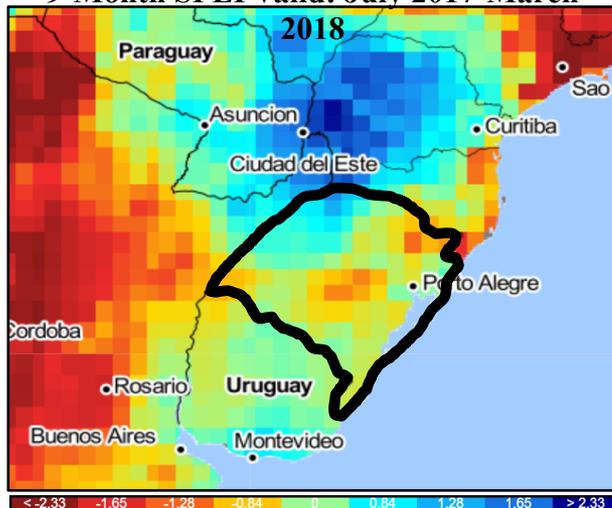
- 14 WS Climate Report: “...our drought monitor shows very little in the way of short-term or long-term drought; some indications of drought are seen in the far northeastern part of the State of Rio Grande Do Sul...” (based on SPI₉)



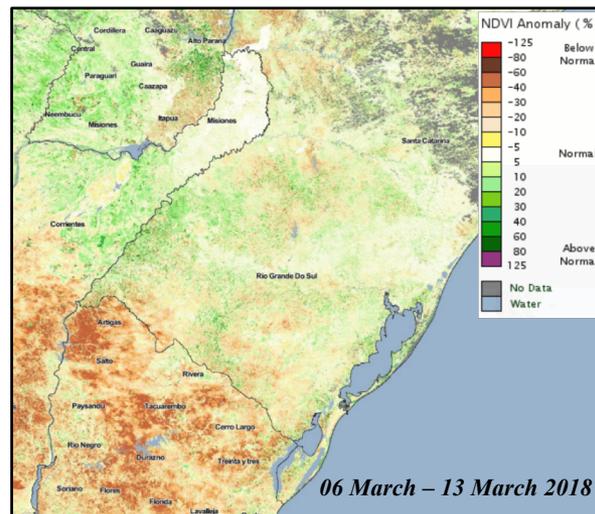
Southern Brazil Drought



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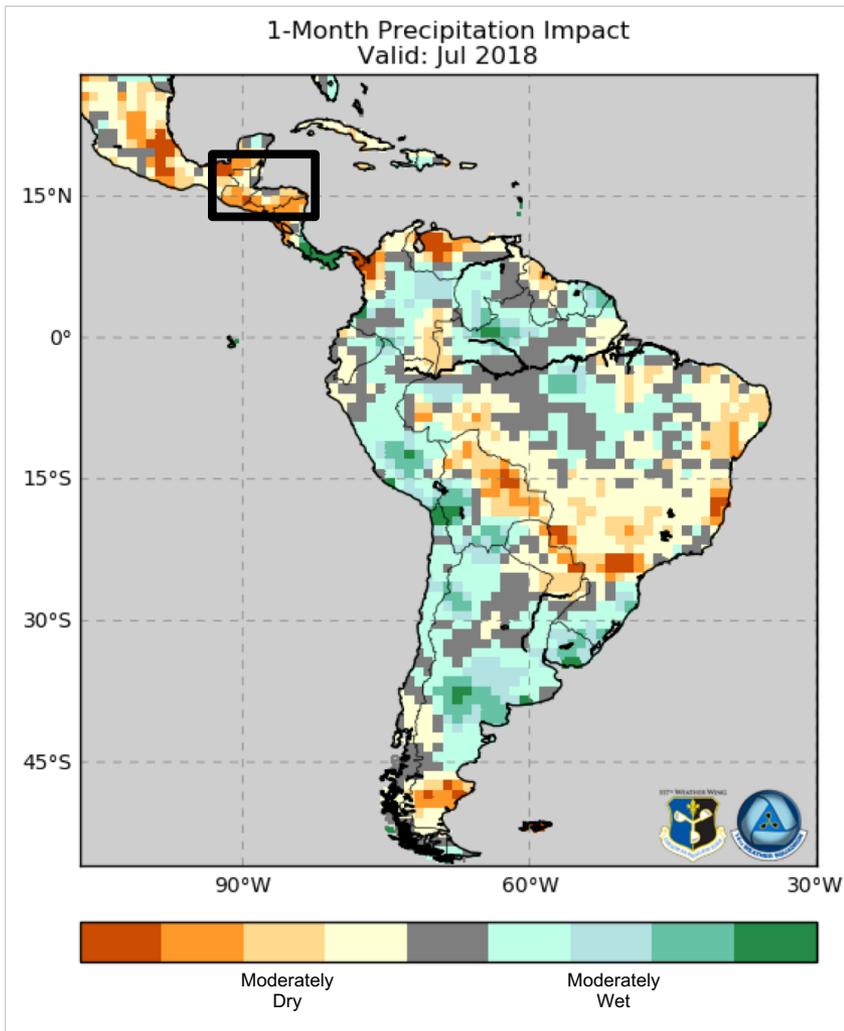


Source: NASA Global Agriculture Monitoring <https://glam1.gsfc.nasa.gov/>

- **14 WS Climate Report:** “However, another drought monitor system we utilize (SPEI) does indicate more in the way of widespread moderate to severe drought conditions, particularly across the northeastern state and the southern half of the state.”
- **Isolated pockets of below normal NDVI anomalies were noted across the northern and southern part of the state.**
- **Soybean yields were down ~50%**
- **Brazilian Army supplied communities with water**



Central America Flash Drought



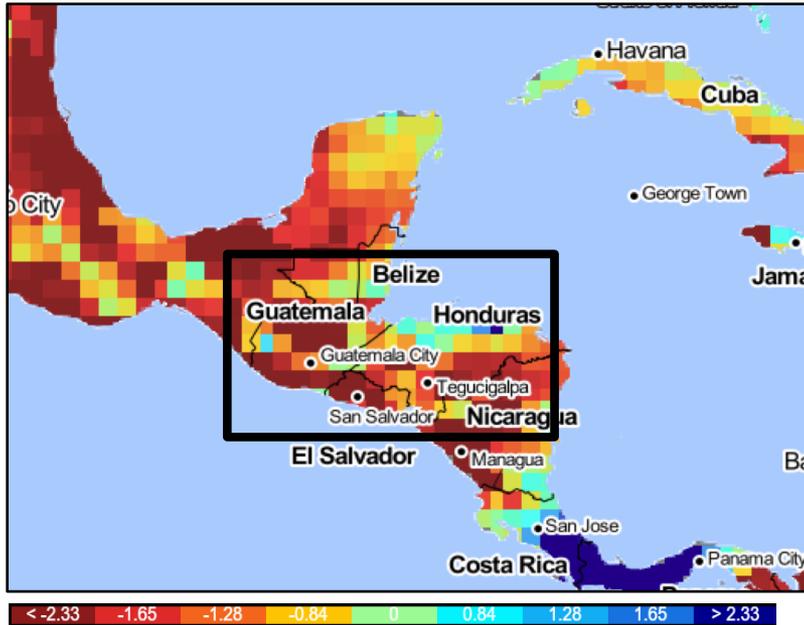
- The 1-month SPI captured the drought signal fairly well.
- Drought developed during a critical productive cycle.
- Significant agricultural impacts:
 - ~80% of corn and bean crops were lost in Honduras and El Salvador, and Guatemala.
 - 2.81 million struggled to feed themselves in Central America.



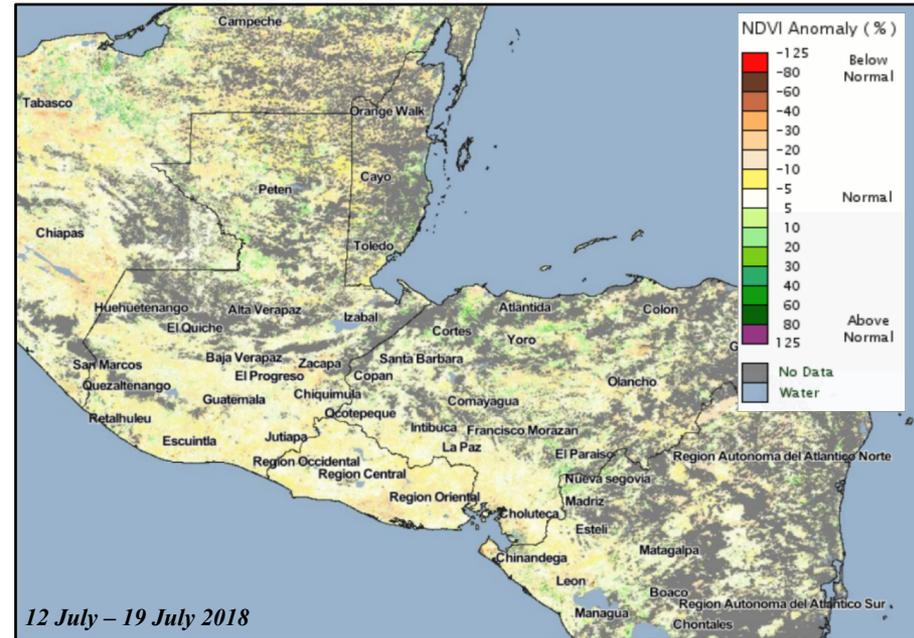
Central America Flash Drought



1-Month SPEI Valid: July 2018



Source: Spanish National Research Council <http://spei.csic.es/map/maps.html>



Source: NASA Global Agriculture Monitoring <https://glam1.gsfc.nasa.gov/>

- SPEI indicated more severe drought conditions, corroborating the significant agricultural impacts.
- Additionally, widespread below normal NDVI anomalies across northern Central America substantiated both drought indices.



End Goals / Summary



- **Improved situational awareness and decision support**
 - **Additional drought indices helped better inform decisions for support and enhanced situational awareness**
- **Further Actions**
 - **Integrate multiple drought indicators into 14 WS drought monitoring, analysis, and prediction**
 - **Leverage external resources and identify collaboration partnerships**

The Moderate Resolution Imaging Spectroradiometer (MODIS) Normalized Difference Vegetation Index (NDVI) used in this study was processed and produced by the NASA/Goddard Space Flight Center's Global Inventory Modeling and Mapping Studies (GIMMS) Group through funding support of the Global Agricultural Monitoring project by USDA's Foreign Agricultural Service (FAS).

Spanish National Research Council gives free access to their products

US drought monitor is releasable to the public.



Questions?



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